

Gas / Electric Infrastructure and Renewable Deployment

Meeting hosted by NCDEQ


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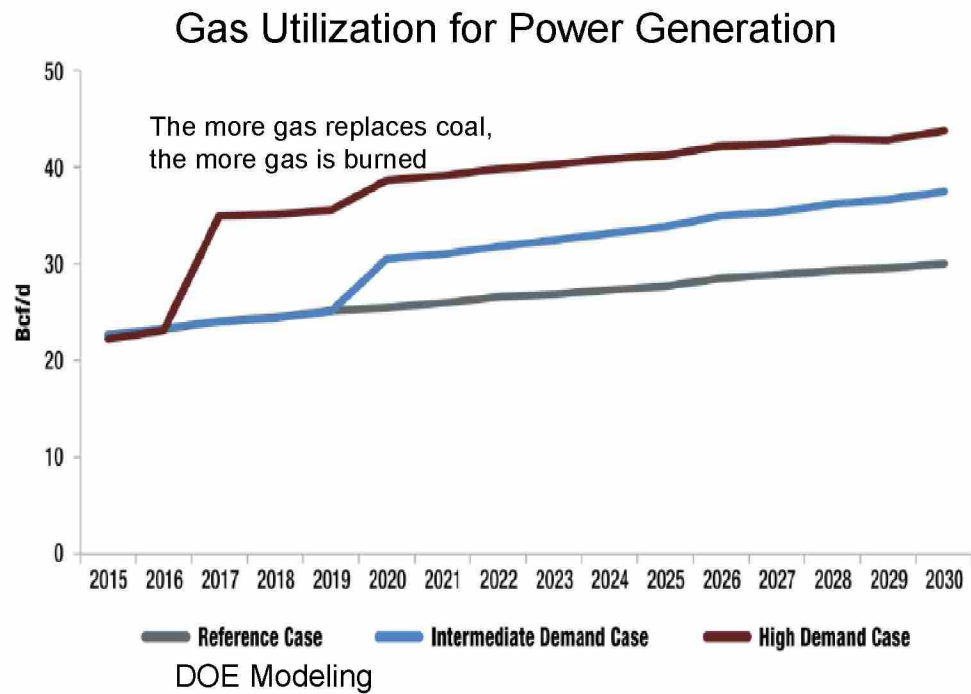
September 28, 2017



Presentation Topics/Summary

- Can 40 year natural gas life-cycle infrastructure (e.g., pipelines, power plants) and climate policy goals co-exist?
 - What benefits can a pipeline provide?
 - What risks?
 - Advancing solutions for the role of gas
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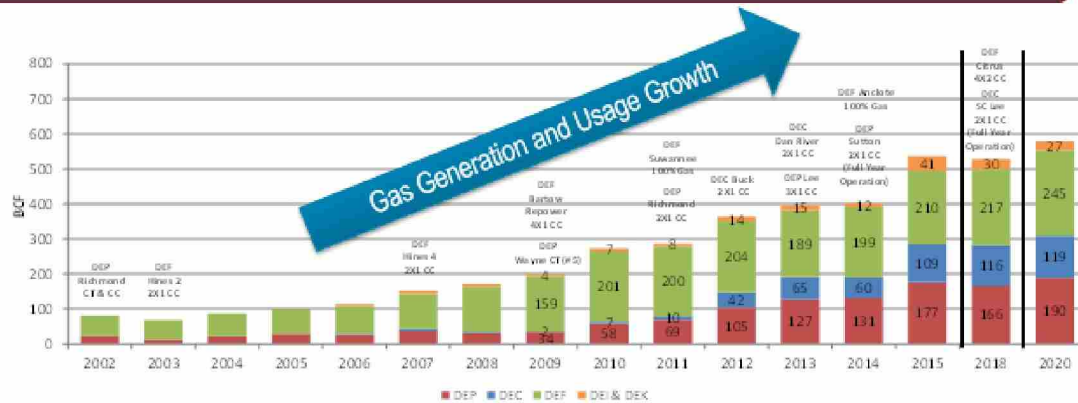
Coal Replacement or Carbon Lock In



Gas displaces coal 2010-2020, but then? DOE's high demand case assumes demand caused by gas replacing coal.

Duke Energy Regulated Natural Gas Generation and Usage Growth

Significant growth in natural gas generation and usage due to coal retirements, CC additions, and conversions.




- Forecasted gas usage for 2015 is over 500 BCF with peak day of approximately 2.4 BCF.
- Currently 12 combined cycle units in regulated generation fleet. Grows to 14 by 2017/2018.
- Estimated regulated gas usage in 2018 is approximately 530 BCF.

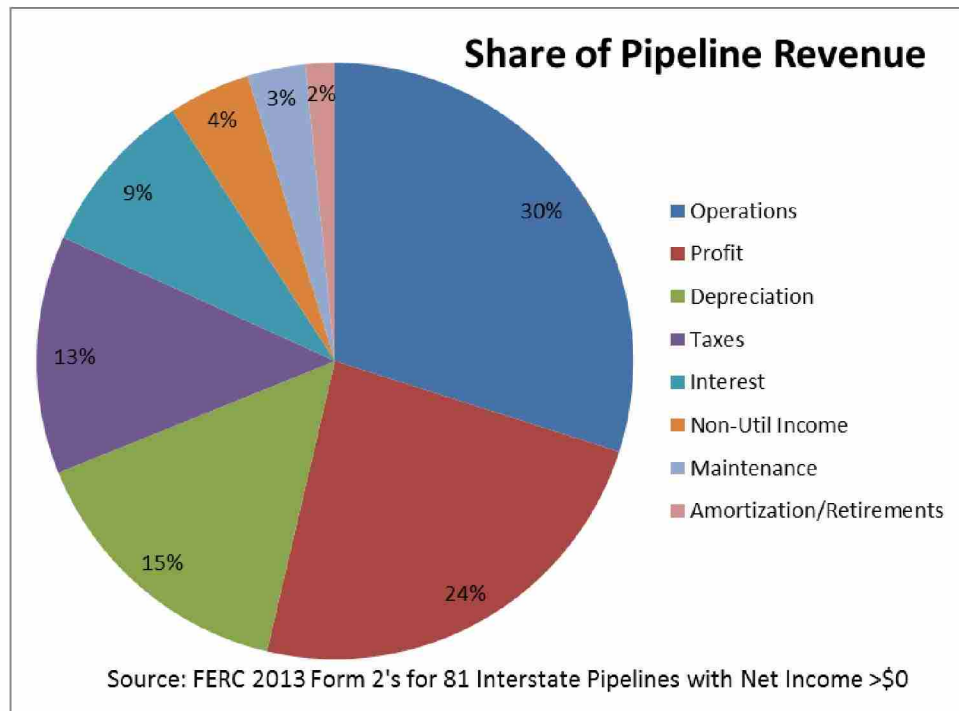


NOTE: Forecasted gas burns are estimates and are subject to change.

Market Design Fundamentals: Natural Gas Pipelines

- Utility incentives: pipeline developers increase ROE by building new pipeline capacity; not the value of services they provide (considering electric grid modernization)
 - Misaligned incentives skew market outcomes (towards excess capacity), particularly when pipeline developers seek to impose on ratepayers risks in excess of benefits to derive shareholder returns
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Pipeline Rates – Set by FERC



Natural Gas Pipeline Rates

Cost of Service + ROE

Straight Fixed Variable

Reservation	Usage
Fixed Costs Return on Equity Related Taxes Long-Term Debt A&G DDA Other Taxes O&M	Variable Costs Nonlabor O&M Other O&M

↑
e.g., \$1.50 mmbtu

↑
e.g., \$.035 mmbtu

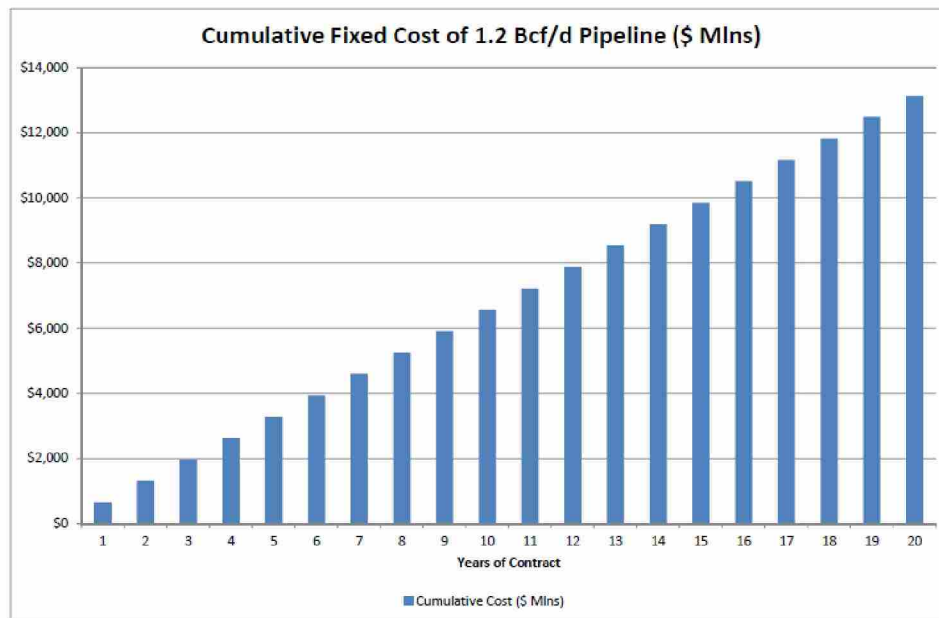
New pipeline builds based on 20+ year take or pay contracts; 40 year financial useful life

Revenue weighted to capacity, not utilization

Pipeline developer commercial focus on ROE, and signing up firm capacity through long term TSAs.

No incentive to fully utilize

Firm = Take or Pay Demand Charge



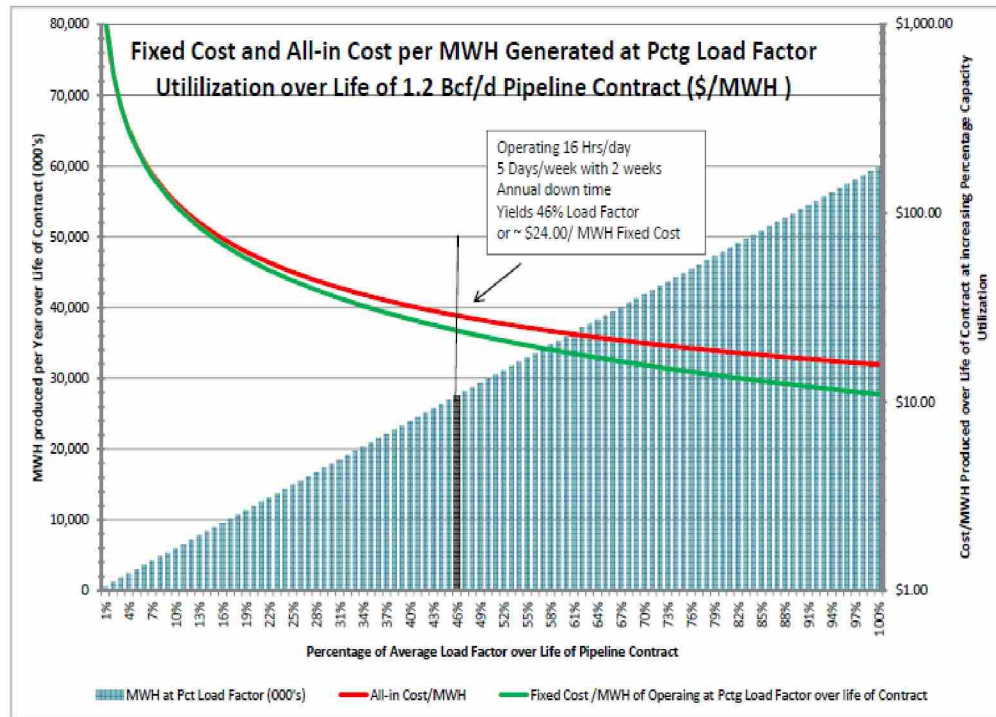
How gas power plants operate.

Vast majority of Gas-fired electric generation does not run at the same level of output every hour of the day.

- Only 6% of Gas-fired Plants and 10% of Gas-fired output is from Plants that run at >80% load factor (Avg is 85%),
- 49% of Plants and 68% of output is from Plants that run at 40% to 80% Load-factors (Avg is 59%); and
- 45% of Plants and ~20% of output is from Plants that run at an average load factor of only 17%

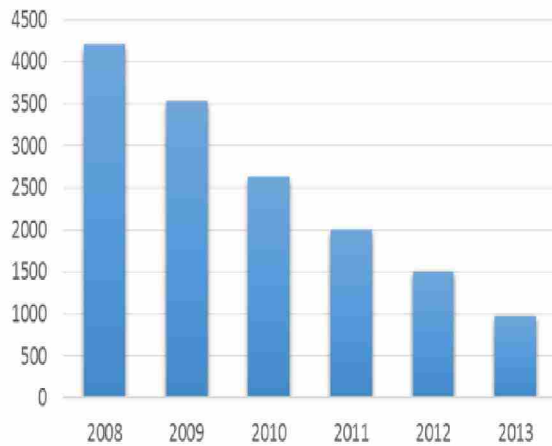
(From EIA data for Plants that ran in the period Jan thru Nov 2015)

The contract incentive is baseload: Cost in Use

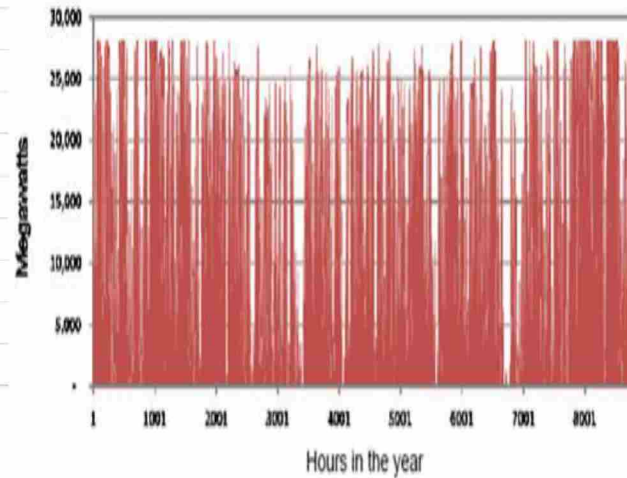


In a more renewable grid: nat. gas provides balancing but operates less.

Spanish CCGT Avg. Operating Hours per Year



Example of CCGT Operations in 2030



Requiring 264 Start-Stops Per Year

Cost in use: Which Power is More Cost Effective for a Vertically Integrated Utility Generator?

- Output from ng plant with firm pipeline transportation contract

- ~ \$.055 kwh

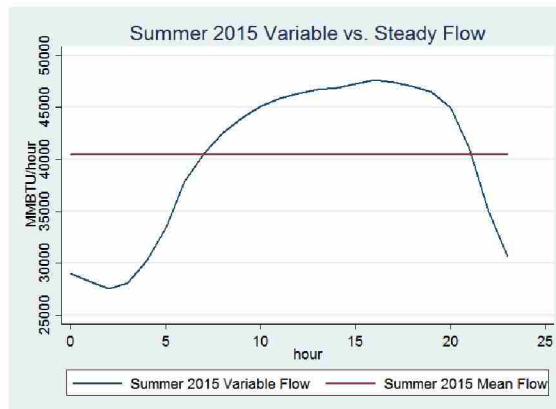
Hint: \$.015 is daily pipe reservation charge

- Output from utility scale solar

- \$.049 kwh

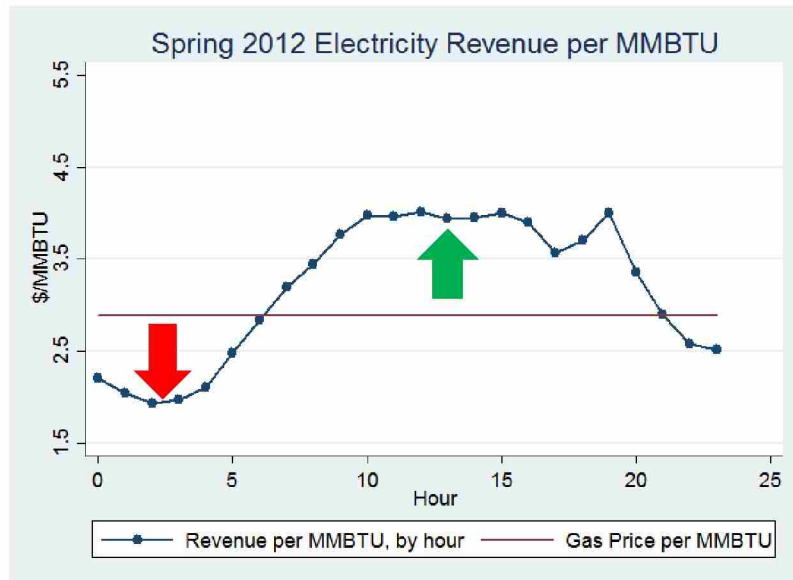
Clean energy lock-out?

Variable vs. Uniform Flow



The gas market design generally assumes uniform hourly (i.e., ratable) flow (flat red line above). Flow used by generators is far more shaped over the course of the day (blue shaped line) to match electrical output with load.

Discord between gas pricing and electricity market needs




The gas market prices assuming uniform flow but gas use and value varies hourly depending on generator demand, especially with more renewables.

So: what does this mean to NC?

§ 62-36.01. Regulation of natural gas service agreements

Whenever the Commission, after notice and hearing, finds that additional natural gas service agreements (including "backhaul" agreements) with interstate or intrastate pipelines will provide increased competition in North Carolina's natural gas industry and (i) will likely result in lower costs to consumers without substantially increasing the risks of service interruptions to customers, or (ii) will substantially reduce the risks of service interruptions without unduly increasing costs to consumers, the Commission may enter and serve an order directing the franchised natural gas local distribution company to negotiate in good faith to enter into such service agreements within a reasonable time. In considering costs to consumers under this section, the Commission may consider both short-term and long-term costs.



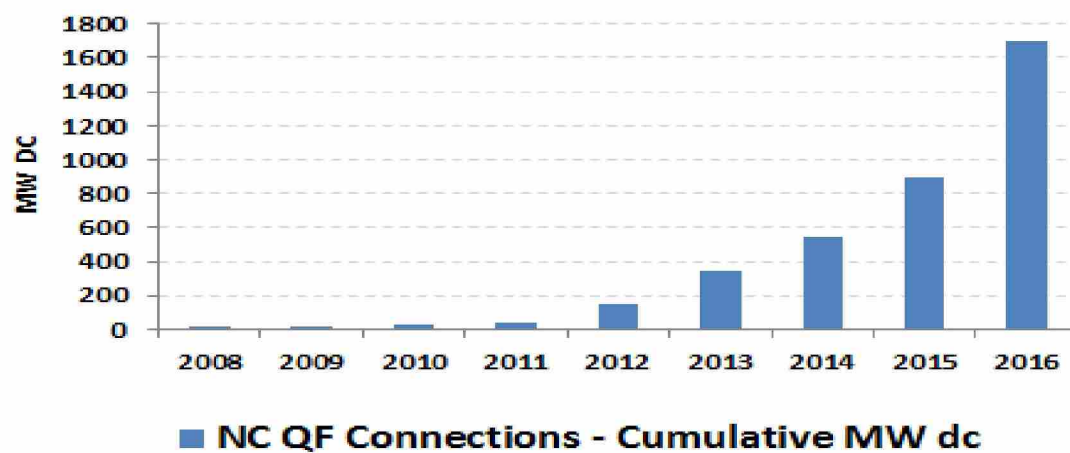
Emerging Electric System – Renewable NC

US planned utility-scale solar projects in advanced development or under construction



Source: SNL Energy
August 20, 2014
Map credit: Alip Artates

Duke Regulated Utility Solar Trend – North Carolina

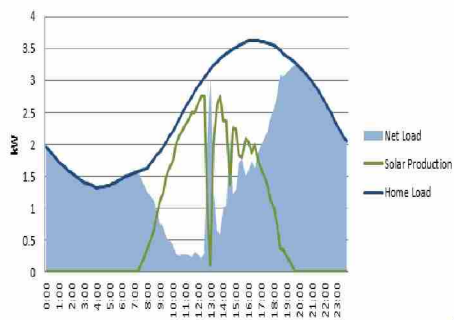


Qualified Facilities include projected on-line MW from purchased power agreements for 2015 and 2016 projections as of March 2015, based on current size of interconnection queue.. Actual additions may be different than illustrated in the graph.

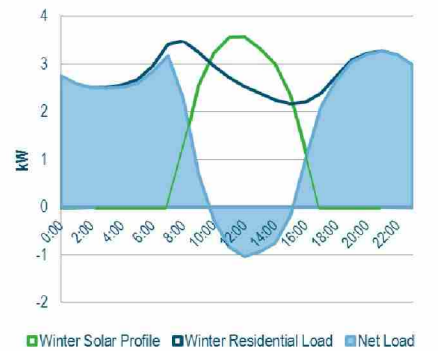
As of December 31,
2014

A day in the life of a North Carolina solar panel....

Residential Customer Summer
Profile (4kW)



Residential Customer Winter Profile
(4kW)



IMPACT: Natural gas transportation contracts & operations with growing renewables

- The “duck curve?”
 - Afternoon ramping and operational flexibility is a concern.
 - How does natural gas delivery support ramping and flexibility needs?
- What regulatory and utility commercial constructs are needed to cost effectively provide for long-term fleet needs to ensure we’re managing and integrating resources effectively.

Dispatching California's "Duck Curve" in 2020: meeting a 33% RPS

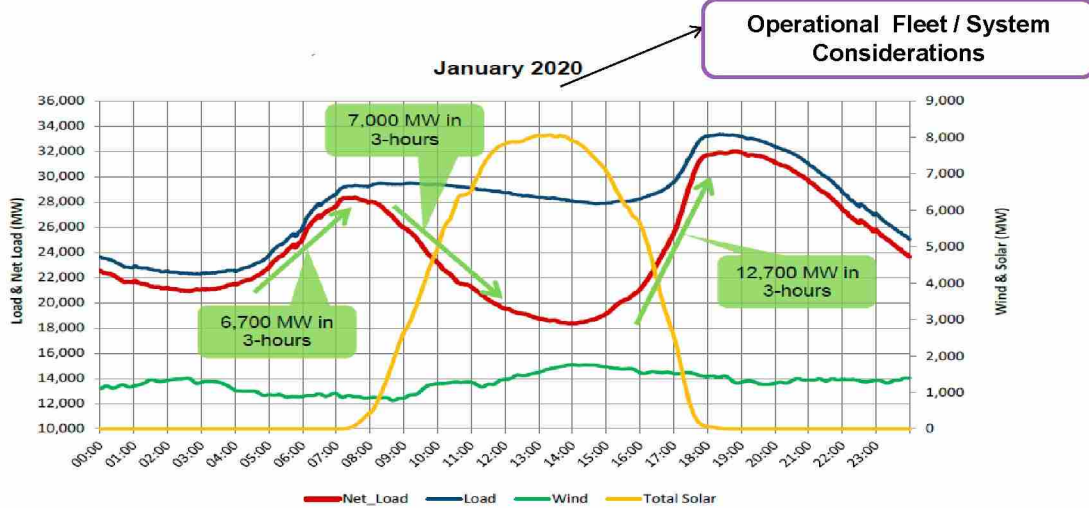


Figure 6: Load, Wind, and Solar Profiles – Base Scenario


Operational capability needed to ramp up and down to balance generation and load.

Source: NERC / CAISO joint report; November 2013: 2013 Special Reliability Assessment: Maintaining Bulk Power System Reliability While Integrating Variable Energy Resources – CAISO Approach

Overarching Goals

- Improve economic and operational coordination between the gas and electric industries
 - Natural gas markets need tools and services to dynamically respond to the reliability needs of gas-fired generators
 - Products and services in each market should generate effective price signals in and across the two markets so that appropriate right-sized investments are made
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EDF's Gas to Clean principles:

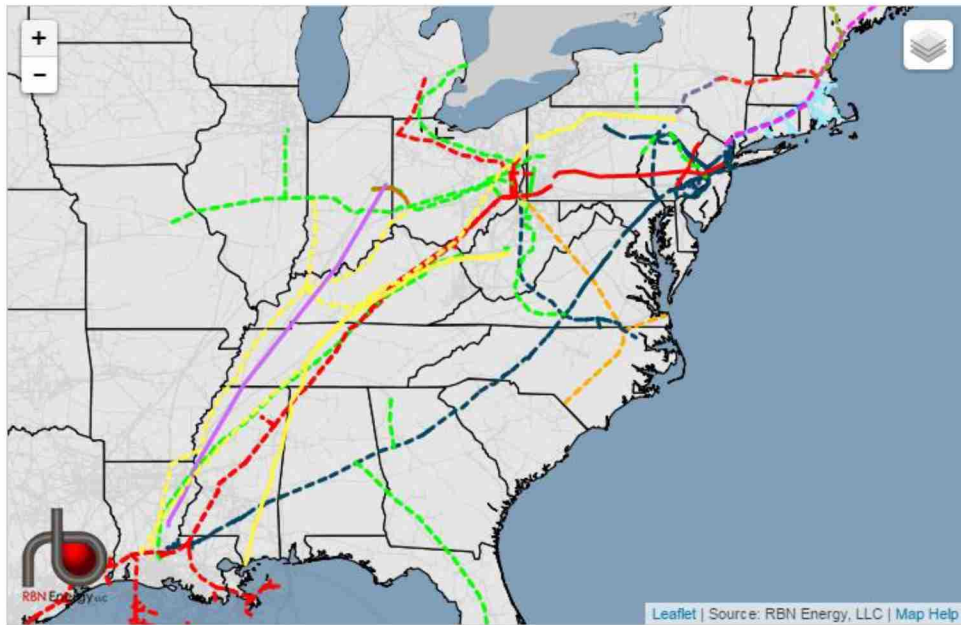
- 1) A more nimble grid and more responsive gas market structure that can better integrate quickly dispatchable resources: storage, demand response solar and a limited amount of responsive natural gas.
 - 2) Gas and electric wholesale markets should be economically and operationally coordinated so that products and services in each market generate effective and actionable price signals in and across both markets, calling forth appropriate, right sized, investments in a timely manner.
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WARNING: Relative ranking table based on specific assumptions and disclaimers documented in white paper—do not use in isolation. Relative scores are based on “typical” capabilities of resources presently being installed.												
		SYNCHRONOUS INTERCONNECTION					INVERTER-BASED INTERCONNECTION				DEMAND RESPONSE	
		Coal	Natural Gas Simple Cycle	Natural Gas Combined Cycle	Nuclear	Hydro	Grid Scale Wind	Grid Scale PV	Distributed PV	Distributed Battery Storage	Large (Industrial/Commercial)	Small (Aggregate)
Volt/Var Control												
Short Circuit Contribution												
Frequency Control	Inertial Response											
	Primary Frequency Response (droop)											
	Regulation											
	Load Following/Ramping											
	Spinning Reserve											
Short-term Availability (fuel)												
Long-term Availability (plant)												
Black Start												


Reliable system operation requires online resources aggregately capable of providing the full range of required reliability services. Synchronous interconnection resources provide the highest contribution across the broadest range of reliability services.

		SYNCHRONOUS INTERCONNECTION					INVERTER-BASED INTERCONNECTION				DEMAND RESPONSE	
		Cool	Natural Gas Simple Cycle	Natural Gas Combined Cycle	Nuclear	Hydro	Grid Scale Wind	Grid Scale PV	Distributed PV	Distributed Battery Storage	Large Industrial/Commercial	Small (Aggregated)
Volt/Var Control		🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	⬛	⬛
Short Circuit Contribution		🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟡	⬛	⬛
Frequency Control	Inertial Response	🟢	🟡🟢	🟢	🟢	🟢	🟡🟢	⬛	⬛	⬛	🟡	⬛
	Primary Frequency Response (droop)	🟡🟢	🟡🟢	🟡🟢	⬛	🟢	🟡🟢	🟡	⬛	🟡	🟡🟢	⬛
	Regulation	🟡🟢	🟢	🟢	⬛	🟢	🟡🟢	🟡🟢	⬛	🟡🟢	🟡🟢	🟡🟢
	Load Following/Ramping	🟡🟢	🟢	🟢	⬛	🟡🟢	🟡🟢	⬛	🟡🟢	🟡	🟡	🟡
	Spinning Reserve	🟡🟢	🟢	🟢	⬛	🟢	🟡🟢	🟡	🟡	🟡🟢	🟢	🟢
Short-term Availability (fuel)		🟢	🟡🟢	🟡🟢	🟢	🟡🟢	🟡🟢	🟡	🟡	🟡🟢	🟡🟢	🟡🟢
Long-term Availability (plant)		🟢	🟡🟢	🟡🟢	🟢	🟢	🟡🟢	🟡🟢	🟡🟢	🟡🟢	🟡🟢	🟡🟢
Black Start		🟡🟢	🟡🟢	🟡🟢	⬛	🟢	⬛	⬛	⬛	⬛	⬛	⬛

Nat Gas Market Update: The system is becoming more reticulated and basis is dissipating.



A reticulated system should offer enhanced receipt and delivery services to power generators such as pack and draft over short periods, providing the intraday flexibility needed to meet the needs of a peakier and more dynamic electric system. But those services are largely unpriced.



“There cannot be a smart, interactive grid unless the business rules governing the means by which gas is traded and dispatched are in sync with the evolving needs of the electric markets.”

**-EDF FERC Comments,
November 2014**

“We continue to recognize that additional intraday nomination opportunities could promote more efficient use of existing pipeline infrastructure and provide additional operational flexibility to all pipeline shippers, including gas-fired generators.”

**-Final FERC Order #809
April 2015**

EDF's interest is threefold:

Maximize use of existing pipeline infrastructure to avoid unnecessary costs and long term carbon lock in through unnecessary long-lived infrastructure – DOE says that 46% of pipeline capacity goes unutilized, and new pipes are not cost effective if need is limited to a relatively small number of days

More flexibility is needed to serve the increasingly more dynamic grid - variability from increased renewable and distributed resource deployment

Gas/electric optimization requires more short term services and products from the gas side to call forth the right mix of assets as renewables displace gas and coal on the economic merits. The electric side balances every fifteen minutes, and increasingly prices on an hourly basis. The gas market balances on a daily basis.

Notably Order 809 calls for additional action for increasing flexibility and enhancing gas/electric harmonization expressly in response to EDF's advocacy in the docket. Specifically, it directs NAESB to assess and develop standards for automating scheduling cycles to bothj increase the number of opportunities to schedule gas deliveries and shorten the process for confirming nominations.


FERC Order 497 – June 1, 1988

The Commission agrees with the commenters who state that the potential for abuse of the pipeline-affiliate relationship exists whether the gas being transported is owned, brokered, or sold by a pipeline's affiliate. The Commission is concerned with a transaction conducted on a pipeline that benefits the pipeline or the corporate group of which it is a part. In such a transaction, there is an economic incentive for the pipeline to favor the transaction. Any affiliate of a pipeline can conduct a transaction which benefits the pipeline or the corporate group of which it is a part. Thus, the Commission is not exempting any affiliate of a pipeline that markets or brokers gas, unless the pipeline does not conduct any transactions with the affiliate.

Conclusions

- Value of point-to-point delivery is diminishing with geographically diverse production and reticulated system (i.e., basis is going away).
- Electric reliability is dependent on a valuable but unpriced service.
- Variable sub-day service offerings are limited and generators are somewhat restricted to what they can bid based on daily index pricing for natural gas supply.
- Shaped flows would allow generators to schedule varying flow quantities of gas for delivery the next day that correlate to their anticipated output levels.
- With updated scheduling and pricing regimes, sub-day flexibility on the gas side can be efficiently priced providing benefit to pipelines, generators and energy customers.
- Price formation would stimulate innovation, investment and competition (e.g., from DR or batteries) in providing the flexible services increasingly needed in the future.

NAESB Process

- Order No. 809 directed NAESB to explore new options and standards for faster and more flexible pipeline scheduling.
 - EDF/Skipping Stone proposed standards for provision of “mutual agreement” scheduling for natural gas pipeline transportation that is:
 - a) scheduled outside of the standard grid-wide nomination cycles,
 - b) permits flow changes outside of standard schedule flow periods; and/or
 - c) involves Shaped Flow Transactions (allow generators to schedule varying flow quantities of gas for delivery the next day that correlate to their anticipated output levels).
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NAESB WGQ Proposed Definition 1.2.[z1]

A Shaped Nomination is a nomination in which a Service Requester provides both a daily quantity and a quantity for each hour of the Gas Day, with each hour beginning at the start of the hour (e.g. 10:00 AM).

NAESB WGQ Proposed Standard 1.3.[z1]

Where a Transportation Service Provider offers a service under its tariff, general terms and conditions, and/or contract provisions which expressly provides for a Service Requester (SR) to submit a Shaped Nomination, the SR should submit its nomination for that service as a Shaped Nomination using NAESB WGQ Standard No. 1.4.1 (Nomination). Receipt of service expressly providing for the use of a Shaped Nomination may require additional coordination with interconnected parties.

A SR utilizing other services that do not expressly provide for the use of a Shaped Nomination should not be required to submit a Shaped Nomination nor does this standard prescribe any affect for services that do not expressly provide for Shaped Nominations.

